Description

In-house subsystem in a mobile radio network

The invention relates to an in-house subsystem in a mobile radio network comprising a fixed home base station, at least one repeater station (repeater) and at least one mobile station. The invention also relates to a method for communication in a subsystem of a mobile radio network and/or of a wired communication network.

A similar subsystem and a similar method are known from international patent application WO 94/19877. This application shows a subsystem in a mobile radio network which has a fixed base station, a repeater station and a plurality of mobile stations, the fixed base station being connected to an external telecommunication network and being connected to a mobile station by means of a transmission/reception antenna. Accordingly, this document also discloses a method for communication in a subsystem of a mobile radio network or of a wired communication network, where, in the subsystem, comprising a plurality of elements, the base station maintains a connection to a mobile radio network and possibly to a landline network and forwards this connection to the at least one mobile station.

The problem arising with this known subsystem is that a single base station is not able to cover a relatively large building, possibly with a number of stories, or else a building complex containing a number of individual buildings and open areas such that all locations are able to set up a good connection between mobile station and base station.

Reference is also made to the applicant's patent application DE 198 20 760 A1, published after the priority date, which solves the problem of adequate coverage. This document shows a broadband communication system having a plurality of wireless communication appliances connected to the telephone network via repeater stations, where the repeater stations are connected to the power supply network and communicate with one another via the latter.

However, a disadvantage of such a system is that each repeater station needs to be connected to a common power supply network in order to be able to communicate with one another. Particularly in the context of relatively large building complexes, problems may arise in this case, because the connection paths via existing power lines can turn out to be very long. This situation is additionally made much worse if the power connections for the individual buildings exist only through transformer stations of the public power supply companies. If the circuits for the different buildings or for the one building are not connected to the same phase, of usually three possible phases, problems additionally arise for communication transmission.

WO 94/03993 discloses an in-house branch exchange in which a multiplicity of wireless base stations are connected, this "wireless" in-house branch exchange using a frequency scanner to carry out for identification and selection of frequencies.

It is therefore an object of the invention to describe an in-house subsystem in a mobile radio network and/or in a wired communication network and a method for communication in a subsystem of a mobile radio network and/or of a wired communication network which provides satisfactory transmission/reception coverage for the mobile stations even in relatively

large buildings and building complexes, including in the associated open-air installations.

This object is achieved both by the features of claim 1 and by the features of the first method claim.

Accordingly, the inventors propose an in-house subsystem in a mobile radio network and/or in a wired communication network which comprises a fixed home base station, at least one repeater station (repeater) and at least one mobile station, the fixed home base station having at least one connection means to an external telecommunication network and at least one transmission/reception antenna for internal connection to the at least one repeater station, the at least one repeater station having at least one connection element for connection either to the home base station or to another repeater station, and at least one transmission/reception antenna for connection either to the at least one mobile station or to another repeater station, and the at least one mobile station having a transmission/reception antenna for communication with the mobile radio network or with a repeater station, all the elements of the subsystem having means which automatically organize the splitting of the system resources between the home base station, the at least one repeater station and the at least one mobile station. The way in which automatic organization works is explained in more detail further below.

It should be pointed out that, in this document, the term "in-house" in the context of the subsystem is used in the sense of the term "residential", as used generally in specialist circles, and is used to distinguish from "public" systems.

One particular refinement of the subsystem according to the invention proposes that the means for automatic organization at least comprise an algorithm for automatically splitting the system resources between intermediate connections present [lacuna] the home base stations, the at least one repeater stations and the at least one mobile station, each element of the subsystem automatically using the system resources on the basis of the same algorithm.

In another advantageous refinement, the connection means in the home base station are/is a transmission/reception unit for wireless communication with a mobile radio network and/or are/is a wired connection to a landline telecommunication network.

In accordance with another advantageous refinement of the subsystem, in the case of at least one line of connection, the communication from the home base station to a mobile station is routed via at least one repeater station or via a plurality of repeater stations communicating with one another.

By way of example, different frequencies and/or different timeslots and/or different CDMA codes (CDMA = Code Division Multiple Access) can be regarded as being system resources which need to be split among one another.

Another requirement within the scope of the invention is that each mobile station, each repeater station and the home base station have a respective PIN (PIN = Personal Identification Number), and the repeater stations and/or the home base station have a means for distinguishing between mobile stations with access authorization and mobile stations without access authorization. Advantageously, the means for distinguishing between mobile stations with access authorization and mobile stations without access authorization can also have a data memory which contains the PIN of mobile stations with access authorization.

For connecting the subsystem to the mobile radio network and to the mobile station or mobile stations, advantageously, the FDD method (FDD = Frequency Division Duplex) can be used for the mobile radio network, and the TDD method (TDD = Time Division Duplex) can be used within the subsystem.

Another advantageous refinement of the subsystem according to the invention is that the at

least one repeater station has means for implementing transfer and/or

acceptance of the mobile station (handover) to/by the home base station and/or to/by another repeater station. This allows a mobile station to move freely within the coverage area of the subsystem while the connection of the mobile station is routed via different connection paths and repeater stations, according to location, or is changed over between different repeater stations and connection paths.

Another, more extensive refinement of the subsystem is that the at least one repeater station have means for implementing connection transfer and connection acceptance for the mobile station (handover) between the mobile radio network and the repeater stations. This achieves further improved mobility for the mobile stations, since unproblematical transfer between an internal connection in the subsystem to the external connection in the mobile radio network is now also possible, without the user's communication being disrupted by this process.

The subsystem described above can, by way of example, be associated with the GSM network (GSM = Global System for Mobile Communications) and/or with the UMTS network (UMTS = Universal Mobile Telecommunication System). Similarly, the subsystem's landline network connection can be associated with the ISDN network (ISDN = Integrated Services Digital Network), with the PSTN network (PSTN = Public Switched Telephone Network), with the power supply network/powerline network and/or with the xDSL/ADSL network (xDSL = general generic term for Digital Subscriber Line, ADSL = Asymmetric Digital Subscriber Line).

The invention also achieves the object which is set above by means of a method for communication in a subsystem of a mobile radio network and/or of a wired communication network, where, in the subsystem, which comprises a plurality of elements containing a home

base station, at least one repeater station and at least one mobile station,

the home base station maintains a connection to a mobile radio network and possibly to a landline network and forwards this connection to the at least one mobile station using the at least one repeater station, and the at least one repeater station automatically splits the resources. This automatic splitting of resources represents automatic organization of the system, the operation of which will be explained in more detail at a later point.

The resource splitting which is possible includes at least splitting the used frequencies and/or the used timeslot and/or the CDMA code (CDMA = Code Division Multiple Access).

Advantageously, with the designated method, only that element (mobile station or base station) which initiates the logical connection setup starts the automatic use of the resources (setup/clear-down of the data channels) between itself and the next connection element in the logical connection chain. If there are one or more repeater stations in the logical line of connection, the respective repeater station performs channel setup for the next element, including automatic resource use.

Another refinement of the method proposes that a repeater station serve a plurality of mobile stations at the same time. This may be done, for example, by virtue of the repeater station(s) operating at a plurality of frequencies at the same time, or each mobile station being assigned one or more timeslots in successive time frames.

One advantageous option for splitting the available system resources can involve the repeater station transmitting on a particular, predefined resource (frequency, code, timeslot), e.g. on a BCCH (Broadcast Control

Channel), or in a particular free timeslot a list of resources already used. In this way, a mobile station potentially initiating a connection knows which resources cannot currently be used.

The method designated above can advantageously be carried out, by way of example, for connection setup initiated from the landline network and/or mobile radio network (incoming call) and/or for connection setup initiated by the subsystem (outgoing call).

With similar advantage, the invention also provides the opportunity to use the method described in more detail above within the subsystem for hand over procedures between the various repeater stations and/or between a repeater station and the base station.

The aforementioned concept of automatic organization in terms of resource splitting denotes a search algorithm which is respectively implemented by base station, repeater station and/or mobile station and assesses the respectively free system resources - which usually comprise frequency, code and timeslot indices - using a quality criterion (e.g. RSSI = Radio Signal Strength Indication = measurement of reception field strength, checking of CRC bits), to determine the extent to which the resources are disrupted or used, and uses a cyclically refreshed look-up table (for frequency, code and timeslot index) to decide which resource is used for data transmission.

An illustrative algorithm may look as follows:

1. Cyclic measurement of reception quality (using RSSI or CRC = Cyclic Redundancy Check) and storage in an electronic table (look-up table).
2. Search for the "best" free transmission resource in the look-up table.

3. Decision on use of a particular resource.

If a data packet is now received with errors, an appropriate ARQ method (ARC = Automatic Repeat on Request) can transmit the data packet again.

Another improvement and optimization, which comes to bear particularly with a large volume of traffic, can involve the repeater station using the BCCH to inform the mobile stations of which resources are already used or which resources cannot be used. This prevents faults (e.g. the simultaneous attempt by two mobile stations to access the same resource).

Other refinements, additional features and advantages of the invention can be found in the description below of preferred illustrative embodiments with reference to the drawings, and in the dependent claims.

It goes without saying that the features of the invention which are mentioned above and are yet to be explained below can be used not only in the particular combination indicated, but also in other combinations or on their own, without departing from the scope of the invention.

The invention will be explained in more detail below with the aid of the drawing.

Figure 1: inventive subsystem for a building complex,

Figure 2: further variant of a subsystem with a different repeater split.

Figure 1 is a schematic illustration of an inventive subsystem with its elements in a building complex having four building parts A-D. The building part A contains a home base

station 3 connected to a mobile radio network 1 via an external transmission/reception antenna 4. The mobile radio network may be, by way of example, a GSM network, UMTS network or other mobile radio network. In addition, the base station is connected by means of a wire line 22 to a landline network, e.g. to the ISDN network, PTSN network or another hardwired communication network 2. For internal communication, the home base station 3 has a transmission/reception antenna 5 which it can use to connect to the other mobile stations 17 and repeater stations 7 and 8 in the building part A.

The repeater station 8 has a transmission/reception antenna 12 and 13 situated in the building part A and in the building part B, respectively. The building part B also contains a transmission/reception antenna 14 for the repeater station 9 from the building part D. The repeater station 9 also has a transmission/reception antenna 15 for the building part D.

The repeater station 6 from the building part A has a fixed connecting line 16 connecting it to the repeater station 7 from the building part C. The repeater station 7 also has a transmission/reception antenna 11 to cover the building part C. The connection 22 between the repeater station 6 and repeater station 7 may also be an optical communication connection by means of LASER or infrared, or else a microwave connection. The connection may likewise be routed via a wireless or wired in-house bus system (e.g. EIB = European Installation Bus, EHS = European Home Systems, Batibus from BatiBUS Club International) or via radio relay, wireless LAN (Local Area Network), twisted pair, four-wire connection, coaxial cable, glass fiber cable, etc.

In addition, each of the building parts can contain one or more mobile station(s) represented

symbolically and provided with the reference numerals 17-20. The radio

connections between the individual elements of the subsystem are symbolized by the arrows 23-29.

All the stationary elements of the subsystem, namely the repeater stations 6-9, including the home base station 3, "know" of one another as a result of their being characterized by a personal identification number (PIN). Similarly, the stationary elements use the respective PIN, which is specific for each mobile station, to recognize whether the mobile station is authorized to access the communication network of the subsystem. If a mobile station with access authorization leaves the coverage area of a repeater station and roams into the coverage area of another repeater station, then a transfer procedure (hand over) from the first to the second repeater station is initiated. By way of example, the mobile station 19 can move from the building part B to the building part D, that is to say can leave the coverage area of the repeater station 8 and enter the coverage area of the repeater station 9. The move from the building part B to the building part D then initiates the transfer procedure, and the connection between mobile radio network 1 or landline network 2 to the mobile station 19 is first handled via the home base station 3 to the repeater station 8 and then via home base station 3 via repeater station 8 and repeater station 9. In the case of this transfer procedure, the distribution of the system resources is regulated locally and automatically, just like when a new connection is set up. The provision of such automatic organization is described above.

A corresponding process takes place, for example, when the mobile station 17 moves from the building part A to the building part C. In this case, the home base station 3 recognizes that the mobile station 17 is leaving its coverage area, while the repeater station 7 recognizes that the mobile station is now entering its coverage area and prompts a

transfer procedure from the home base station 3 to the repeater station 6 and repeater station 7.

If, by way of example, the mobile station 18 moves from the building part C into the building part D, then the repeater station 7 recognizes that its area is being left, and the repeater station 9 registers the entry of the mobile station 18 into its coverage area. The transfer procedure is thus used to transfer the connection for the mobile station 18, which was initially routed via the repeater stations 7 and 6 to the home base station 3, to the repeater station 9, which routes its connection to the home base station 3 via the repeater station 8.

This allows unrestricted mobility of the mobile stations within the building complex with its building parts A-B, with each location providing optimum connection to the mobile network 1 and/or landline network 2. The mobile stations are also able to roam during an existing connection without interruption.

In the case of a relatively large building, repeater stations can thus be set up on the individual stories. With relatively large building complexes having a number of buildings and open terrain, one or more repeater stations can be installed for each building, for example, and one repeater station can be used for the open terrain, the home base station being able to reach all repeater stations via one or more repeater stations, and the available system resources being split automatically.

Another variation of the subsystem according to the invention is shown in figure 2. The fundamental difference with respect to figure 1 is that the repeater station 8 is not in the building part A, but rather is installed in the building part B. In addition, the building part D has no repeater stations.

Such a situation is conceivable when the physical separation between the building parts A and B, on the one hand, and

the building parts B and D, on the other hand, is small enough, in construction terms, or is close enough, in physical terms, for the radio link 23 between the home base station 3 or possibly another radio link from another repeater station to be sufficient to reach the repeater station 8. Similarly, there is no need for a repeater station to be present in a building part, as in the part D in this case, if this building part is also covered by a repeater station positioned elsewhere.

The fundamentally important aspect when splitting the intermediate stations is thus that there is adequate radio coverage for the rooms, and a direct or indirect connection can be set up between the mobile terminals and the home base station from each location as far as possible. In this context, it does not matter how many repeater stations are needed for the connection.